

## THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE BELT OF NEW SOUTH WALES.

PART VI. APPENDIX. THE ATTUNGA DISTRICT.

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(One Text-figure.)

In the main portion of this report (1, *d*), an account was given of the region extending from Warialda, the northern limit of the visible part of the Serpentine Belt, to the Namoi River. It was intended to survey in greater detail the complex region between the river and Moore Creek, thus joining on to the area already mapped in the Tamworth District south of Moore Creek, and with the survey of the Loomberah District to be considered in Part vii., of this series of papers, in order to complete the mapping of the Great Serpentine Belt, in greater or less detail, from Warialda to Nundle. The writer's removal from Australia makes this now impossible. It seems advisable, therefore, to place on record the work already done, upon which was based the mapping of this area in the Plate accompanying Parts i. and vi.; and to indicate the modifications required, as shown by later information obtained by the writer, by Lieut. Aurousseau, B.Sc., M.C., and by Mr. S. M. Tout, and by Mr. L. J. Jones. The present communication, therefore, is a compilation of incomplete information gathered by several workers, and will serve chiefly to draw attention to the interesting nature of the material awaiting further research. The writer's thanks are due to the generous permission given by the gentlemen named to make use of their work, and to the Government Geologist, Mr. J. E. Carne, for permission to show, on the accompanying sketch-map, the boundaries of the limestones in the area between Attunga Creek and the Namoi River, which are copied from the surveys of Mr.



The region exhibits a varied series of formations. From Willowtree Creek northwards, there extends intermittently the line of serpentine-intrusions. To the east of this are the crushed and altered rocks of the "Eastern Series," which here belong, apparently, to the Lower Middle Devonian formation, in great measure. They consist of crushed and sheared, banded cherts, agglomerates, and volcanic breccias, with lenticular masses of limestone, probably of the Nemingha horizon; and, here and there, a mass of serpentine. This can be well seen along the Valley of Wiseman's Arm Creek. Between these and the Serpentine, however, is a long ridge of red jasper culminating in the peak Bungemullagalaro, south of Hall's Creek. North of this creek is a low gap leading to the Namoi River between the jasper ridge by the Serpentine line to the west, and the scarp of the New England plateau to the east, a scarp which is, in part, of tectonic origin.

The serpentine varies greatly in width. It is scarcely more than a yard wide near Willowtree Creek, but is nearly a quarter of a mile wide by Hall's Creek. The larger masses of serpentine here do not occur in the Serpentine Line, but strike north from near Ukolan through the above-mentioned gap to Mundowey, thus indicating a virgation of the tectonic lines.

Returning to the south: near the head of Horsearm Creek, limestone occurs, and extends across into Willowtree Creek, where the outcrop reaches a width of nearly 400 yards, probably broken by faults. It dies out before reaching Attunga Creek, but appears again north of the creek (in Portion 151, Burdekin), where it is very tuffaceous, weathering to a cavernous rock. This suggests that this limestone belongs to the Nemingha horizon, which is supported by the abundance of igneous material, tuffs, breccias, dolerite, etc., immediately west and stratigraphically above the limestone, which probably indicates the position of the Igneous Zone known to overlie the Nemingha limestone (1, c). Beyond Portion 151, the Nemingha limestone passes to the east of the Serpentine Line, and its extension has been traced up through Wiseman's Arm Creek to Crow Mountain. It does

not return to the west of the Serpentine Line until near Bingara.

The granites are of the type of the Moonbi, hornblendic granite, with numerous basic inclusions(1, b, p.696). They invade the limestone on Horsearm Creek, truncate the Serpentine Line, and pass obliquely through the Eastern Series to Mt. Abundance, where the margin of the granite turns to the east. Especially interesting and varied examples of contact-metamorphism occur along the margin of the granite. At the head of Horsearm Creek, the claystones have been entirely recrystallised, with the formation of sillimanite(1, b, p.704). Nearby, the limestones are intensely altered, especially in Portion 226, Attunga. Here they have been largely replaced by brown garnet, and impregnated with orthoclase and albite; while copper-ores have been introduced. Many, beautiful, partially oxidised specimens may be obtained from the dump of a small prospecting pit near here. (See, for example, the specimens now in the Mining Museum, Sydney). At the head of Willowtree Creek, the copper minerals are sufficiently abundant, in the contact-altered rock, to warrant exploitation. A brief account of the Attunga Copper Mine here has been given by Mr. Carne(3). The petrological features of these contact-altered rocks have been described by the writer(1, b, pp.713-714).

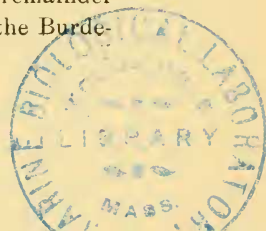
Very interesting, too, are the contact-effects of the granite upon the rocks of the Igneous Zone overlying the limestone, in which are a number of types of altered tuff and breccia, which have been already briefly described, and may be compared with similar rocks from the head of Seven Mile Creek, in the Tamworth district, eight miles to the south(1, b, pp.710-711; and 1, c, pp.607-608). In addition, a massive dolerite has been observed in which the augite has been replaced by strongly pleochroic hornblende, and secondary biotite has been developed(1, b, p.668).

West of the granite is a series of dykes of lamprophyre, usually pink in colour, with finely divided, ferromagnesian minerals. These are chiefly vogesites, and occur, *e.g.*, at Bunge-mullagalarno, and on Wiseman's Arm Creek, and at Mundowey to the north. A typical minette was obtained on Willowtree

Creek (1, *b*, pp. 697-8; p. 706, analysis); and a lamprophyre, the nature of which is not known to the writer, was found by Lieut. Aourousseau in Portion 159, Attunga (see below).

West of the Igneous Zone, there extends, through the Parishes of Attunga and Burdekin, a monotonous series of banded cherts and claystones with interbedded tufts, giving, as a rule, very unsatisfactory outcrops. These belong to the Upper Middle Devonian Series, and contain masses of limestone. To the west, the Upper Devonian rocks follow, forming the plains of the Peel River. North of this, however, the central mass of Upper Middle Devonian rocks seems to be flanked, to the east as well as to the west, by Upper Devonian Mudstones; and, in Portions 47 and 48, Parish of Halloran, evidence of the occurrence of an unfolded strip of Carboniferous rocks has been found by Mr. S. M. Tout, lying adjacent to the serpentine, repeating, in this manner, the features observed at Crow Mountain, and extending thence down to the Namoi River (1, *d*).

The chief interest lies in the great masses of limestone, which occurs here in greater abundance than in any other part of the Great Serpentine Belt. Numerous separated masses lie within the broad area marked as limestone in the map given in Part i. (1, *a*). The resistance offered to erosion by the limestones is so much greater than that of the claystones in which they occur, that they generally rise into sharp hills, often thickly wooded with pines. Just as in the region south of Moore Creek, these masses of limestone prove to be isolated portions of folds, compressed and faulted, the whole indicating an extremely complex tectonic structure, though the intervening mass of claystone is so imperfectly exposed, that no complete solution of the structural problem can be obtained. Thus, in the Parish of Attunga, the mass in Portions 158 and 74 has the structure of a laterally compressed dome or anticline, the axis of which pitches to the north-west at the northern end of the hill, and south-west at the southern end. It is faulted along the eastern side. The limestone here is very thick, probably at least four hundred feet, the lower two hundred feet or so being pure limestone, the remainder with siliceous and other impurities. The hill behind the Burde-



kin Homestead, south of Attunga Creek, similarly is a strongly compressed fold, apparently a syncline, in which the limestone must be not less thick than the above. Faulted against this, on its north-western side, is a mass of claystone and limestone (60 feet thick of pure limestone, above 70 feet thick of siliceous limestone dipping E.N.E. at  $10^{\circ}$ ). The very irregular outline of the masses of limestone north of Attunga Creek, the mapping of which is due to Mr. L. J. Jones, suggests that a similar complexity of tectonic structure prevails here. This is confirmed by the extraordinarily disturbed character of the sediments on Yarrambully Creek. The following fossils have been obtained from the Attunga limestones by various collectors,\* the determinations being due to Mr. W. S. Dun, for the most part (4, 5).

<i>Tryplasma</i> , sp.n.	<i>Actinocystis cornuboris</i> .
<i>Cyathophyllum</i> , sp.n.	<i>Aulopora</i> sp.
<i>Phillipsastræa</i> sp.n.	<i>Microplasma parallelum</i> .
<i>Litophyllum Konincki</i> .	<i>Litophyllum</i> , sp.n.
<i>Heliolites porosa</i> .	<i>Syringopora auloporoides</i> .
<i>Syringopora</i> , sp.n.	<i>Favosites gothlandica</i> .
<i>Favosites multitabulata</i> .	<i>Pentamerus</i> cf. <i>Knightii</i> .
<i>Chonetes</i> sp.	<i>Atrypa</i> sp.
<i>Euomphalus</i> sp.	Crinoid ossicles.

Unfortunately, the exact localities from which these fossils were derived are not known to the writer; the majority are not frequently found in Moore Creek limestone, to which must belong the bulk, if not all, the masses of limestone. The presence of *Phillipsastræa*, *Tryplasma* sp., and *F. multitabulata* suggests that the Loomberah limestone may also be represented. If this be so, we may have here an opportunity of checking the present tentative assumption that the Loomberah limestone is stratigraphically intermediate between the Moore Creek and Nemingha limestones, though nearer to the former. It should be noted that, in one place at least, namely on the top of the hill behind the Burdekin Homestead, the limestone of the Moore Creek horizon is brecciated, and set in a red matrix, in a manner previously believed to be confined to the Nemingha limestone. For

\* W. Anderson, M. Aourousseau, J. Campbell, C. Cullen, R. Etheridge, D. Porter.



further details of the field-occurrence, chemical composition, etc., of these limestones, reference must be made to Messrs. Carne & Jones' forthcoming work(2).

In Portion 159, Attunga, the western of the two large masses of limestone (carefully surveyed by Lieut. Aurousseau), has a locally developed, strong contact-alteration. In the dusk of an evening, in 1910, the writer collected a number of specimens from here, but did not work out their field-relationships. These were subsequently described in detail, and, from the occurrence of cassiterite and scapolite in them, it was concluded that they lay near the end of a granitic apophysis with a pneumatolytic, metamorphosing effect. A few felspathic rocks, rich in calcite, etc., suggested an endogenous alteration of such an intrusive mass(1, b, pp.714-716). Lieut. Aurousseau, however, discovered a vein of lamprophyre invading the limestone, and he believes that it was the cause of the metamorphism. He gives the following account of the change of the limestone in the few yards adjacent to the lamprophyre:—i., The dyke; ii., calcite-phlogopite rock; iii., dark limestone; iv., phlogopite rock; v., melanite-wollastonite rock, with clinozoisite, vesuvianite, calcite, mica(?), and pyroxene; vi., vesuvianite-wollastonite rock with a little melanite; vii., saccharoidal limestone. Evidently, the small collection, already described by the writer, is fairly typical of the whole occurrence. The nature of the intrusive rock is not known. There is here, accordingly, an interesting field for study in comparison with Bergeat's descriptions of endogenous and exogenous contact-metamorphism in Mexico(5).

The only other feature of interest, in the Middle Devonian rocks observed by the writer, is a small mass of vesicular spilite, east of the railway near Somerton Road Station.

The passage from the Middle to the Upper Devonian beds is not always marked, as was formerly believed, by the development of an intervening mass of Baldwin Agglomerate. Indeed, the study of the southern part of the Tamworth district shows that passage from the dominantly cherty rocks of the Tamworth type, into the soft mudstones of the Barraba type, may take place considerably below the base of the Barraba system, marked

by Baldwin Agglomerates. (This will be discussed in more detail in Part vii.). There is no reason, therefore, for assuming, from the absence of Agglomerates, the presence of a fault separating the Middle and Upper Devonian beds at Attunga.

To the east of the limestone-occurrences in Parish Cuerindi, the radiolarian cherts give place to claystones and mudstones, which, as shown in the earlier map, are probably of Upper Devonian age; and these are followed by other mudstones and tuffaceous sandstones adjacent to the Serpentine, which are comparable with the Burindi (Carboniferous) rocks by the Serpentine at Crow Mountain. Attention was first called to the fossils obtained from these beds by Mr. S. M. Tout, and their age was determined by Mr. W. S. Dun. *Spirifera* cf. *striata*, var., and *Aviculopecten* sp., were recorded by him in Mr. Tout's collection. No sedimentary formations more recent than these (excepting river-alluvium) have been observed in the area studied.

The dominant physiographic feature in this region is the granite plateau, from which there is a sharp fall to the rocks of the Eastern Series, followed by a series of foothills steadily descending to the Peel River and Namoi plains. The isolated mass of Round Hill, west of Somerton Road, was not visited by the writer, but is probably Baldwin Agglomerate.

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